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**Backgrounder: Good agricultural practices for vegetable production in Ghana**

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**Introduction**

***Why is this subject important to listeners?***

Because farmers involved in vegetable production should know:

* The land preparation required to grow vegetables.
* The types of vegetables to grow in their region.
* How to manage growing vegetables on their farm.
* How to control pests in growing vegetables.
* The right time to harvest mature vegetables.
* Diseases that affect growing vegetables and how to identify and manage them.
* The nutrients required for growing vegetables and how to identify nutritional deficiencies.

***What are some key facts on vegetable production?***

* Vegetable farmers should buy certified and treated seeds, unless growing organically, in which case seeds cannot be treated.
* Farmers can sow their vegetables seeds on a seed tray in a growing medium or in an open field nursery. Seedlings raised on trays have a higher survival rate than ones raised in an open field nursery, but raising seedlings on trays requires more time and materials.
* Media used to produce vegetable seedlings should have good water-retention capacity but be well-drained enough to avoid waterlogging, be firm and dense enough to hold seeds, and contain no foreign objects like rocks or stones.
* Vegetable seeds can be planted in seed trays with growing media that contain soil, sand, and fibre (for example, coconut fibre) mixed with manure. Sand should be sourced from rivers and be clean, and manure should be well-composted.
	+ If topsoil is clayey, mix one part topsoil with two parts sand or similar material and two parts decomposed manure.
	+ If topsoil is loamy, mix one part topsoil with one part sand or similar material and one part decomposed manure.
	+ If topsoil is sandy, mix one part topsoil with one part decomposed manure and add 10% fibrous material. Do not add sand.
* Space cabbage seeds 2-3 centimetres apart in nurseries, with rows 8-10 centimetres apart.
* If farmers sow seeds in a nursery bed, they can mix them with sand to ensure that seeds are not too close together.
* Using seed trays ensures that seedlings are uniform in growth, that diseases don’t easily spread, and that seedlings have high survival rates when transplanted to the field.

*For further information, please see documents 1, 3, 7, 9, 10, 12, 13, 14, and 15.*

***Predicted impact of climate change on vegetable production in Ghana***

* In recent years in Ghana, longer periods of drought have been threatening vegetable production.
* In Ghana’s Volta region and around Accra, irrigation has introduced opportunities for vegetable farming.
* In northern Ghana, extreme droughts have been associated with high temperatures, soil infertility, and diminished capacity for the soil to retain moisture.
* Every decade since 1960, Ghana’s average annual temperature has increased by 1°C, while monthly rainfall has decreased by about 2.4%. This can create water and heat stress that triggers pest and disease outbreaks, resulting in loss of productive land from ecosystem decline, and falling yields.
* Bad weather has caused farmers to minimize production of pepper and other vegetables in the Volta region.

*For further information, please see documents 2, 4, 6, and 8.*

***What are the big challenges of vegetable production in Ghana?***

* Prolonged droughts and poor rains have made vegetable farming challenging for Ghana’s small-scale farmers.
* Small-scale farmers may not be able to afford technologies like solar irrigation kits that can help them water their crops during droughts.
* Pests and diseases that infest growing vegetables.
* The high costs of planting materials and other farming inputs.
* Using diseased or inferior planting materials results in poor yields.
* Farmers lack sufficient knowledge of how to properly grow vegetables.
* The cost of hiring labourers.
* Growing vegetable varieties that are not resilient to drought and resistant or tolerant to pest and disease attack.

***Gender aspects of vegetable production in Ghana***

* Chili farming in Ghana provides economic opportunities for low-income women who dry, process, and market it.
* In Ghana, men dominate irrigated urban vegetable farming, while women dominate vegetable marketing in rural Ghana, particularly leafy vegetables.
* Low levels of vegetable consumption contribute to malnutrition among women and children in sub-Saharan Africa’s urban and peri-urban environments.
* In northern Ghana, women grow short-season crops such as corchorus and other leafy vegetables*,* okra, tomatoes, and eggplants to supplement available household foods. These are harvested three months after planting, much sooner than traditional staples like cassava and maize.

*For further information, please see documents 5 and 11.*

***Key information about good agricultural practices for vegetable production in Ghana***

***Land preparation***

Good land preparation is important for vegetables to grow and yield optimally.

* Slash weedy or bushy land and remove stones, stumps, or branches before ploughing.
* Ploughing breaks down soil, softens it, and buries plant residues. It also turns over the upper soil layer to bring fresh nutrients to the surface and kills soilborne pests by exposing them to sunlight.
* For vegetable production, the plough’s blade should penetrate 25-30 cm into the soil. Farmers should consider using a ripper\*.
* Harrow ploughed soil to fine crumb structure and smooth the soil surface, as vegetable production is best suited to soil with fine particles. This structure enables air circulation and improves drainage.
* Prepare nursery beds on harrowed land.
* Remove any weeds related to the vegetables being planted since they host pests and diseases that infest or infect growing vegetables and compete for soil nutrients.
* Whenever possible, conduct soil tests before transplanting seedlings to identify missing and needed nutrients.

***Soil preparation for planting seedlings***

For vegetable seeds to mature into healthy seedlings, farmers need to properly prepare the soil. Planting soil should be:

* Firm and dense to hold seeds in place during germination.
* Well-drained.
* Free from foreign objects like weeds and stones.
* Free from nematodes, pathogens, viruses, and toxins.

Before planting vegetables, farmers should sterilize the soil: Sterilizing hampers weed growth and pest infestation, destroys pathogens, and prevents damping off of seedlings. Here are some techniques for sterilizing soil:

* *Steaming:* Steam sterilize the soil for 12 hours in an old drum with hot steam running through it from another drum containing boiling water. After sterilization, let the soil cool for 24 hours before planting seeds. Agronomic experts advise farmers to use this method only for soil used in seed trays as it destroys beneficial soil organisms.
* *Solarization:* This method is ideal for nurseries and involves covering the already wetted soil with transparent polyethylene sheets held down with rocks. The sheet should be kept in close and tight contact with the soil. On sunny days, temperatures under the plastic sheet reach up to 70 degrees Celsius or higher. To allow the soil to heat to the greatest depth possible, solarization should continue for to six weeks. When conditions are not sunny, soil solarization may take longer than six weeks. Farmers should not use black plastic as it absorbs heat rather than heating soil.

**Production of specific crops**

1. **Cabbage production**

Cabbages grow best in full sunlight and need an average temperature of 15-18 degrees Celsius for quality head growth. After transplanting, cabbages require up to 90 days to mature, depending on the variety. They require a soil pH of 6.0 to 6.5 and a minimum of 25 litres of water per square metre of field per week in areas where there is no rain and continuous hot and sunny weather, and more if planted on sandy soil or in areas with high levels of transpiration. Cabbages grow best in well-drained sandy loam soil rich in organic matter as they require a high level of nutrients. Farmers should plant certified and treated cabbage seeds in nursery seedbeds unless growing organically, in which case seeds cannot be treated.

***Nursery***

* Nursery beds should not have contained cabbages in the previous season or other brassica family vegetables such as cauliflower, collard, broccoli, and kale. These vegetables can host brassica pests and diseases.
* Nursery seedbeds can be raised or sunken. Raised beds are best suited for wet regions and sunken beds for dry areas or dry seasons.
* Nursery beds should be 1-metre-wide and 30 centimetres high. The standard length is 4- 5 metres but can be longer, depending on available land.
* Mix soil with composted manure. Refer to the *Key facts on vegetable farming* section above for mixture ratios.
* The recommended seeding rate is 300 grams per hectare.
* If farmers use their own cabbage seeds or open-pollinated varieties, these should be immersed in hot water for 30 minutes at 45 degrees Celsius.
* Hot water treatment is an alternative to using fungicides.
	+ Place seeds in a loose cotton bag and submerge in a large pot with plenty of water/ Heat the water to 45 degrees Celsius, not allowing the bag to touch the bottom of the pot. When heating up, the water should be so hot that it is too hot to keep your hand in it. Leave seed for 15 minutes without further heating while keeping the pot covered. Stir constantly.
	+ Remove the bag and cool in clean, cold water.
	+ Spread seeds on clean, dry paper to cool.
	+ When possible, sow immediately rather than storing.
* Space nursery rows 8-10 centimetres apart across the shorter dimension of the field to establish shorter rows.
* Sow seeds 2-3 centimetres apart at a depth of 1-1.5 centimetres.
* Cover cabbage seeds with a mixture of fine soil and sieved farmyard manure.
* Cover the nursery bed with dry rice straw or dry *Grevillea robusta* leaves and water it. Straw and leaves should remain on the soil surface until transplanting to conserve soil moisture. Farmers can also build a temporary roof over the nursery bed to shade and protect it from heavy rains.
* Water the nursery bed lightly with a watering can with fine holes. Water early in the morning.
* Monitor the nursery for weeds and remove when necessary.
* Thin weak seedlings to avoid crowding.

***Transplanting and nutrient management***

After 5-6 weeks, transplant 10-12 cm high cabbage seedlings with 4 to 6 leaves. Transplant in the evening and irrigate transplanted seedlings. Before transplanting, conduct a soil test. If nursery soil is low in organic matter, add 1-2 handfuls of composted manure or compost to the planting hole and mix with soil.

* Space transplanted seedlings 45-60 cm apart in rows 45-60 cm apart.
* At planting, apply 5 grams of NPK (15-15-15) fertilizer per seedling. After two weeks, top dress with 3 grams of urea fertilizer per seedling and re-apply six weeks after planting.
* Apply 50 kgs of nitrogen fertilizer per hectare when seedlings begin to establish. Apply a second top dressing at 100 kilograms per hectare when leaves start folding to form heads.
* After transplanting, irrigate seedlings immediately. Seedlings grown on heavy soils should be irrigated again after 10 to 12 days. On light soils, irrigate after 8 days. Continue to irrigate until heads are formed and firm.
* After heads form, avoid overwatering to ensure that heads do not crack.

***Pest management***

Farmers can adopt an Integrated Pest Management (IPM) approach to manage cabbage pests. IPM focuses on long-term pest prevention and management by using a variety of approaches, including growing resistant or tolerant varieties, using living organisms to manage pests, and using cultural practices that make the farm unsuitable for pests and diseases. IPM recommends minimal pesticide use and spot spraying only after pests are scouted and detected.

**IPM approach to cabbage pests**

**Diamondback moth:** This moth burrows into cabbage leaves, sucks the sap, causing white-brown scars.

* When cabbages have four leaves, farmers should start scouting weekly for small, thin, light-grey-greenish larvae on the undersides of leaves and on stems.
* To reduce diamondback moth populations and damage, intercrop cabbage with chilis.
* To repel diamondback moths, plant onions, coriander, garlic, or tomatoes 14-30 days before transplanting cabbage seedlings.
* Spot spray neem seed and oil extracts and insecticidal soaps to prevent attack by diamondback moths.
* Dipel (a safe and effective insecticide containing the bacterium *Bacillus thuringiensis*) can be sprayed when diamondback caterpillars are seen and thereafter every two weeks, with repeat sprayings after heavy rains.
* Plant turnip rape or Indian mustard on field edges 12 days before transplanting. These act as trap plants that lure the diamondback moth away from cabbages.
* Irrigating the farm in evenings with overhead sprinklers can disrupt moth flight and dislodge them from leaves, thereby increasing mortality.
* Farmers can use suspend yellow sticky traps 2-4 feet above the ground to trap diamondback moths and monitor their numbers. Alternatively, they can leave a soapy bucket of water on the farm to trap moths. If sticky traps capture five or more moths per week, farmers can use one of the following control methods:
	+ Spray pesticides that are effective in managing diamondback moth. For example, farmers can spray Dipel every two weeks, with repeat sprayings after heavy rains.
	+ Spray a hot pepper mixture. Grind seeds to powder, mix 20 grams of powder with one litre of water, store overnight, and then sieve through fine material such as linen. Spray on cabbages once weekly until one week before harvest. Add a few drops of oil or soap to the mixture so the spray sticks to cabbage leaves.

**Aphids:** Mealy, false, and green peach aphids attack cabbages by sucking sap and causing leaves to yellow and become deformed. Aphid colonies are found on the undersides of leaves.

Intercropping cabbage with spinach, beans, clover, grass, or dill minimizes aphid infestations. Spraying neem oil or neem seed extract on growing cabbages will also prevent aphid damage.

*For further information, please see documents 3, 7, 9, and 13.*

1. **Chili farming**

Chili pepper grows best in well-drained fertile soils rich in organic matter and with a pH of 6.0 to 6.5, though it can produce in soils with a pH of 4.5 to 8.0. Light sand, clay sandy, and sandy loams are ideal for farming peppers. The ideal soil temperature is 18-25 degrees Celsius.

***Nursery***

Farmers should conduct a soil test before establishing a nursery to determine if there are soilborne pathogens and which nutrients are missing. Nurseries should be located in areas with free-draining soils. Well-rotted farmyard or compost manure can be added to soil to improve structure and organic matter.

***Seeding***

Chili seedlings can be seeded directly or seedlings can be transplanted from nurseries. Certified seeds raised in nurseries have a higher germination rate. If farmers use their own seeds, they should be from high-yielding, disease-free, and mature chili plants. The seeding rate is 200-250 grams per hectare. After removing seeds from chili pods, soak seeds in clean water for two hours and dry to improve germination.

* A standard chili nursery bed is 1.5 metres wide, 6 metres long, and 15 centimetres high.
* Farmers should incorporate 60 kilograms of well-composted manure into the top 10 centimetres of nursery soil.
* To improve poor soil structure, mix topsoil with sand and composted manure in a ratio of 3:2:1, and add to polystyrene seedling containers that are 3 inches in diameter.
* In nurseries, plant chili seeds 1-1.5 centimetres deep and space 15-20 centimetres apart.
* After planting, cover nurseries with dry mulch or shed netting and water with fine droplets once a way.
* Seeds germinate 1-3 weeks after planting.
* To harden\* chili seedlings, partially remove shade and mulch and reduce watering to three times per week.
* Harden when chilli seedlings approach 12-15 centimeters in height, about two weeks after planting.

***Transplanting and nutrient management***

When transplanting chili seedlings, farmers should:

* Irrigate if the soil is too dry to form a fine tilth\*.
* Add mulch to conserve moisture and inhibit weed growth.
* Ensure seedlings are 5-6 weeks old, have 4-6 leaves, and are 7-10 centimetres high.
* Transplant at the start of the rainy season when daytime temperatures are low, preferably during the evening.
* Water nurseries to make it easier to uproot seedlings and ensure that the rootball\* has plenty of soil.
* Space transplanted seedlings 60-70 centimetres apart in rows 30-40 centimetres apart, depending on the variety.
* Transplant seedlings into holes that are 10 centimetres deep.
* Cover seedlings if the location has high temperatures and cover with shed netting after transplanting.
* Before transplanting, apply 10 tonnes of composted manure per hectare and 80 kilograms of a phosphorus fertilizer like diammonium phosphate. For organic chili, apply compost from five to seven 1.5-metre-high compost piles (producing about 700 kg of compost each) per acre of chilis.
* Cattle manure can be placed in jute bags and submerged in water for two weeks before applying to chili plants as liquid manure.
* Before top dressing, test soils to determine which nutrients are needed. Apply the first top dressing chili plants are 15 centimetres high and a second 4 weeks later.
* Work fertilizer and manure into the soil with a hoe.
* After transplanting seedlings, irrigate so they establish, but don’t overwater.
* After transplanting, apply a mulch of dry plant residue between rows to preserve moisture and suppress weed growth.
* In regions where annual rains are less than 600mm, irrigation is recommended to prevent fruit and flower abortion.
* If you observe symptoms of magnesium deficiency during vegetative growth—yellowing between the veins of older leaves while the veins remain green—farmers can apply Epsom salt, sold inexpensively in chemist stores. Mix two tablespoons with four litres of water and spray on leaves till the liquid runs off. If symptoms are acute, spray once a week for four weeks. Continue for one more 4-week period if symptoms persist.
* In acidic soils, add 40 kilograms of CAN fertilizer per acre. In alkaline soils, add 50 kilograms of sulphate of ammonia if a soil test shows that pH is over 7.0.
* During flowering, chili plants require additional potassium, boron, and phosphorus. Apply 125 kg of both potassium and phosphorus per hectare 7-10 days after planting. Add 2-5 grams of boron during the vegetative stage.
* If flowers appear 10 days after transplanting, remove to encourage vegetative growth.

**IPM approach to chili pests**

Pests affect growing chili starting at the seedling stage. The main pests are cutworm, whitefly, borer, thrips, aphids, and spider mites. Here are some IPM approaches and practices to manage these pests.

* Consistently monitor chili farms and remove pests by hand or spot spray where infestations are concentrated.
* Plough and harrow to unearth pests like thrips pupae, cutworms, and borers that hide in the soil to expose them to sunlight where they die of desiccation.
* Before transplanting chili, farmers should remove weeds that harbour pests like cutworm moths.
* Farmers can make circular collars from paper, cardboard, and aluminum foil and sink them an inch into the soil around each seedling. The collars are ten inches long and four inches high and stop cutworms and other caterpillars (worms) from accessing plants.
* Practices like field sanitation, weeding, intercropping, crop rotation, using traps and trap crops\*, managing soil nutrients and water, and planting pest- and disease- resistant varieties can minimize pest buildup in the field.
* Hot chili extracts can be sprayed on growing plants to control aphids that hide under leaves, flowers, and stems, where they suck sap and spread viral diseases. Spraying horticultural and neem oils and insecticidal soaps are also useful against aphids.
* In Ghana, farmers can spray the biological insecticide Dipel when they first see false codling moth caterpillars and repeat every two weeks. An additional spray is recommended after heavy rainfalls.
* Farmers can prune chili leaves infected with spider mites and then destroy them or uproot entire plants. Spray horticultural and neem oils directly on adult mites, eggs, larvae, and nymphs every three days until infestations are managed.
* Whiteflies feed on plant sap, leaving behind a sticky liquid that attracts a sooty mould. Spraying horticultural oil stops all growth stages of whiteflies.
* Farmers can place sticky yellow traps to trap and manage whitefly infestations in the field.

*For further information, please see documents 1, 12, and 15.*

1. **Onion farming**

Onions yield best in well-drained, fertile soils with a pH of 6.0-6.8. Onions grow at sea level to 1900 metres, and prefer well-distributed rains ranging from 500-700 millimetres and a temperature of 15-30 degrees Celsius. At maturity, dry weather is required. Fine sandy to silt loam soils are ideal for onion farming. Refer to the hot water seed treatment in the cabbage section to learn how to treat onion seeds. Seedlings can also be treated with fungicides.

***Nursery***

An ideal size for an onion nursery bed is a maximum of one metre wide and five metres long. To prepare soil for a nursery bed, remove soil to a depth of 15 cm and keep it aside. Add plant materials such as tree leaves, bananas, or green maize to the soil, and add 20 kg of well-composted manure and 20 grams of Diammonium Phosphate (DAP)/Triple Super Phosphate (TSP) fertilizer for each square metre of the nursery, then mix and cover with the removed soil. Space seed rows 15 cm apart and plant seeds 5 cm deep, then cover lightly with soil and mulch. Germination occurs in 7-10 days.

***Transplanting***

Before transplanting onion seedlings, farmers should conduct a soil test to identify which nutrients need replenishing and add them. Irrigate the nursery bed one day before transplanting so that seedlings are not damaged when uprooting. Farmers can sow 6-8 kilos of onion seed per acre.

* Transplant in the morning or afternoon for improved establishment.
* If you mulch the nursery with dry grass or rice straw, remove it when seedlings begin emerging. Any plants used as mulch should have narrow rather than broad leaves to allow sunlight and water to more easily penetrate.
* Apply 80 kilograms of Triple Super Phosphate (TSP) fertilizer per acre before transplanting.
* Transplant seedlings plants at 6-10 weeks old, depending on variety. At that stage, onion plants are 10-15 centimetres long.
* Plant in holes 2.5-3 centimetres deep and spaced 5 to 10 centimetres apart in planting rows 20-30 centimetres apart.
* Thirty days after transplanting, top dress with 40 kilograms of Calcium ammonium nitrate (CAN) per acre.
* Weed 21 and 45 days after transplanting to keep onions relatively weed-free. Weeding makes onions less susceptible to thrips infestations.
* Top dress with 100 kilograms of CAN per acre 30 days after transplanting.
* When top dressing, place fertilizer in the planting furrow adjacent to the onions, where onion roots can reach it for nutrients.
* Unearth soil around onion bulbs during the second weeding to allow them to grow to maturity.
* Ensure onion sets are not buried more than an inch under the soil. To improve seedling establishment in nurseries, cut 50 percent of tops off seedlings, but leave about 10 centimetres of the stem.

***Watering***

Watering depends on the growth stage:

* Irrigate immediately after transplanting with 3-5 litres of water per square metre of field to keep the soil cool and moist.
* In hot and dry conditions, irrigate twice daily.
* Lighter soils require more watering than heavier soils.
* Increase watering as plants and roots enlarge, but minimize as bulbs near full maturity.
* Onions stressed by drought often split into two or more bulbs.
* Consistent irrigation prevents onions from water stress, which can increase susceptibility to thrips infestations.

***IPM approach to onion pests***

The main pests that attack growing onions are onion thrips and onion flies. If not managed, they lower decrease yield and quality. Practices to manage onion pests and diseases include the following.

* Soil sterilization, steaming. and solarization before planting minimizes soil pests.
* Incorporate neem cake into the soil to enhance nutrient availability, improve plant resistance, and reduce soil pathogens.
* Plant the healthiest and most disease-resistant onion bulbs. They should be pest- and disease-free and the strongest and most vibrant seedlings.
* Plant castor to trap oriental leafworm moth, which feeds on leaves.
* Grow maize as a barrier crop to prevent thrips from moving into onion fields.
* Rotate onions in alternate seasons with non-host crops to reduce the incidence of soilborne diseases and pests like onion flies.
* Mulch onion farms to retain soil moisture, minimize insect pests, mites, and disease, and improve growth.
* To improve fertility and minimize soilborne diseases, add neem cake, mustard oil cake, or compost manure to the soil. These also help increase soil microbes that help plants absorb nutrients.
* Add calcium and nitrogen to the soil to reduce onion thrips infestations.
* Uproot and destroy thrips and fly-infested onion plants.
* Use neem to manage thrips on infested plants.
* Add well-composted manure to reduce onion fly infestations.
* Maintain field sanitation to prevent onion fly infestation.

*For further information, please see documents 9, 10, and 14*

***Definitions***

*Hardening*: Gradual preparation of seedlings to field conditions by, for example, reducing the frequency of watering, removing barriers to wind flow, etc.

*Ripper:* An attachment used to tear and rip apart soil, particularly compacted and heavy soils.

*Root ball*: The soil that remains on plant roots after they are uprooted.

*Seed dressing*: Drenching seedlings with an insecticide or fungicide, whether biological or synthetic, to protect them from soilborne diseases and insect pests.

*Tilth:* The condition of the soil and its suitability for planting and growing crops. A soil with good tilth is loose with fine and easy-to-crumble particles, granular and not compacted.

*Trap crops*: Crops planted on field edges or intercropped with the main crop to lure insect pests to feed on them instead of the main crop. Trap crops reduce pesticide use.

***Where can I find other resources on this topic?***

*Documents*

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